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Strange, Sexless, Superhuman Tones: An Exploration of the Whistle Register in Western Classical Singing

von

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Abstract

The whistle register is useful, essential even, for certain operatic repertoire, yet it is not always taught. This paper examines how it has been trained historically as well as more recent methods. The modern scientific literature on the mechanism of the whistle register is discussed and case studies of singers of the past with particularly high ranges are provided. Guiding questions include: How does one learn to sing high? What is the mechanism of the whistle register? Who could sing high, and was it even pleasant? Why bother with these notes at all?

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Prologue

I am not a person for whom singing came easily or naturally. It wasn't until the All-Aramco Choir Festival of 2003, that I thought of singing as anything that I did other than for myself. That year I got the opening solo of one of the big tutti pieces, and it changed my life. Instantly singing became central to my identity and sense of self, a silent obsession for a girl whose identity was as the quiet, shy, smart kid, until 7 years later I declared a music double major and finally showed that it was what I wanted to be doing more seriously, or at least in addition to science.

But it took forever to figure out. To be a rather shy person, essentially afraid of one's own voice, especially of singing high and therefore loud: this is not helpful when one is a soprano. I took voice lessons from age 15, and by age 25, while I had made significant progress, I still felt like my voice was a fickle foreign object, disembodied, that was not under my control. I could hear that I was not perfect and did not know how to fix or change anything. I was also at 25 experiencing some technical problems, particularly in the notes in the secondo passaggio, which would occasionally crack and split and leave me afraid, making me then even have a harder time singing these notes.

I wound up on the bench of Anat Keidar. She wanted to rework my whole conception of how I sang. I was ready, this was what I had been searching for in a teacher. I wanted to understand my instrument as a physical thing, rather than thinking the notes and having them come out of the self in my head rather than the self in my body. I placed myself in her hands, and after a year and a half of abstract exercises, I felt like I was finally starting to understand my instrument.

Anat took me high, to fix my problems by going higher than the associations of my lower voice, the "singy thing," and it was in the abstract version of my voice that I was able to detangle my voice from my self, put it into my body and then begin to work on it. Up until this point, I had never heard of anyone working on the voice in this way, on training these high notes, let alone training them first. It surprised me then to find in a musicology book, a field that all too rarely deals with the practicalities of making music, an account describing a similar process for training these notes.

The Fourth Voice

The following excerpt is an account from the soprano Emma Calvé's autobiography *My Life*, describing her experience hearing the castrato Domenico Mustafà in the Sistene Chapel in 1891:

> He had an exquisite high tenor voice, truly angelic, neither masculine nor yet feminine in type – deep, subtle, poignant in its vibrant intensity. He sang the classic church music admirably, especially Palestrina. He had certain curious notes which he called his fourth voice – strange, sexless tones, superhuman, uncanny!
>
> I was so much impressed by his talent that I decided to take some lessons from him. The first question I asked was how I might learn to sing those heavenly tones.
>
> "It's quite easy," he answered. "You have only to practice with your mouth tight shut for two hours a day. At the end of ten years, you may possibly be able to do something with them."
>
> That was hardly encouraging!
>
> "A thousand thanks!" I exclaimed. "At that rate, I will never learn! It takes too much patience!"
>
> Nevertheless, with the tenacity which is a fundamental part of my character, I set to work. My first efforts were pitiful. My mother assured me that they sounded like the miauling of a sick cat! At the end of two years, however, I began to make use of my newly acquired skill; but it was not until the third year of study that I obtained a complete mastery of the difficult art.
>
> These special notes, which I have used since then with great success, are rarely found in the ordinary run of voices. I have tried repeatedly to develop them in my pupils; but, in spite of hard work and close application, I have never found one pupil who has been able to imitate them.
>
> While I was studying in Rome, I overheard one of my comrades remark that, after all, this "fourth voice" was nothing but a trick. Much vexed, I told Mustapha what had been said.
>
> "Let them howl!" he answered. "Our friends call our achievement trickery when they cannot do the same thing themselves. As soon as they have learned the art, they call it talent."[1]

When I first read this passage, tucked into a section on high notes in Martha Feldman's *The Castrato*, I was stunned – this was precisely the way Anat taught me, using essentially a hum to reach these top notes, and then eventually opening them up. I had never heard of anyone else approach teaching the high register this way, and here was an obscure anecdote from a 19th-century singer explaining a very similar process. I felt vindicated in my choice of a teacher, which I needed because the process of working with her was difficult and frustrating,[2] and legitimized by this description, knowing that the process that Anat was using to teach these high notes did have precedent. Like for Calvé, it had also taken me about two years of

[1] Calvé, *My Life*, 64–65.

[2] While the information she gave me was exactly what I wanted, one of her main teaching tools was to yell "no" at me repeatedly – I am use many things in my own teaching that I learned from Anat, but I refuse to yell "no" at my students.

working with Anat for these notes to open up for me. I also felt a kinship with Emma Calvé that for her too, these notes were a novelty, something she had to learn, and something she did not typically encounter in other singers, her own previous teachers, or in her students.

But what is this fourth voice – is it the whistle register? This description of it as the fourth voice does seem to imply this, with the described quality of "strange, sexless tones, superhuman, uncanny" pointing to a different vocal mechanism being employed for these notes. Descriptions of registers in the 19th century often use the divisions of chest, medium and head voice, and so this fourth voice would be another on top of these three, implying a different timbre if not also a different mechanism. Indeed, in Emma Calvé's diary, published in 1940, she provides a supplementary description of these notes, even identifying the specific pitches:

> I am beginning to be able to use the little flute-like notes taught by Mustapha. These very special sounds, of a tenuity, lightness and pretty timbre, will allow me to approach very easily the D, E, F, above the staff, very gently. They are reminiscent of the harmonics of the violin, which Lily Lehmann talks about in her treatise on singing.[3,4]

The description of these notes as "flute-like" again points towards the whistle register, as do the pitches themselves – *d'''*, *e'''*, and *f'''* are often the notes of the whistle register. (I personally transition around *c#'''*, though can transition on *c'''* or *d'''*.)

High notes are a perennial source of fascination, perhaps most especially to those who cannot or do not know how to produce them. Calvé's description of Mustafà's high fluty notes as "strange, sexless tones, superhuman, uncanny," speaks to their greater than human quality, and her immediate desire to possess these notes demonstrates their power to fascinate. In opera, the Queen of the Night's high *f'''*s are often what people come to see in *The Magic Flute*, and the role is one of the most iconic in the genre because of them. In pop music, the names Mariah Carey and Minnie Ripperton immediately bring to mind the spectacular high notes of their whistle registers. It is these highest notes in the voice, the notes lying in the whistle register, that I wish to explore in this study. The whistle register is above the head voice register, and is defined by vocal pedagogues as beginning around *a''* for contraltos, *b''* or *c'''* for mezzo-sopranos, and *d'''* for sopranos.[5] How was this register trained in the past, how it can be trained now? What is the mechanism of this register, as well as the research knows

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[3] "Je commence à pouvoir me servir des petites notes flûtées enseignées par Mustapha. Ces sons très spéciaux, d'une ténuité, d'une légèreté et d'un joli timbre, vont me permettre d'aborder très facilement le ré, mi, fa, au-dessus de la portée, en grande douceur. Ils rappellent les harmoniques du violon, dont Lily Lehmann parle dans son Traité de chant."

[4] Calvé, *Sous Tous Les Ciels j'ai Chanté...:Souvenirs*, 55.

[5] Miller, *Training Soprano Voices*, 25.

now? What was the scientific understanding of this register in the 19th-century? Where do we see the use of this register in Western classical singing? Where should we use it now? We will continue with Mustafà and Calvé as the first stop on this journey.

Domenico Mustafà and Emma Calvé

Domenico Mustafà (1829-1912) and Emma Calvé (1858-1942) were both hard-working and independent-minded, which is apparent in the anecdote above. Both were ready to undertake this process of learning these notes, even if they did not have other contemporaries who were employing them, as is evident from Mustafà's haters-gonna-hate mentality about those who call their fourth voice "trickery" when they do not possess it themselves. It takes a good amount of faith and grit to trust a long process when one has not seen much evidence of the outcome, and Calvé herself describes her own "tenacious" character as an asset in learning these notes. Calvé did not even have any students who were able to stick with this process and learn to sing these notes. This tenacity seems to have been essential in the acquisition of this notes.

Mustafà demonstrated this dedication to his craft throughout his life. He served in the Sistine Chapel choir from 1848 until his retirement in 1895, and he was the director of this choir from 1860 onwards. He was renowned for the quality of his soprano voice, which had a large range, but was also known as a composer[6] and a teacher, as the following letter written to the *Post* in 1875 relates:

> Don Domenico Mustafa is a colossal specimen of a singing chaplain, and his voice is or used to be of the purest soprano, with a very extensive range. His method of teaching being considered excellent, he was for many years very *répandu* among English families visiting Rome as a singing master, and his fluty warbling used to constitute the unbounded wonder and admiration of his fair pupils.[7]

The reference here to his "fluty warbling" inciting the wonder of his students echoes Emma Calvé's experience hearing Mustafà. His high notes may have been an ability he would show off occasionally, or perhaps this "fluty" sound is a reference to the quality of his soprano castrato voice, which would have been a novelty to these English tourists. Unfortunately, no solo recordings of Mustafà survive that would have allowed us to know what he sounded like, and we can only trust the accounts that we have.

Soprano Emma Calvé (1858-1942) was renowned not only for her singing but also for her acting. Originally from the Aveyron department in France, her voice was discovered to

[6] Mannucci, *L'Arte a Roma: Biografie Dei Maestri Di Musica*, 97–98.
[7] "Foreign Musical Intelligence," 56.

be beautiful while she was a child in a local convent school. In 1879 she moved to Paris where she studied with Jules Puget, and she debuted in Brussels in 1882 at Marguerite in Gounod's *Faust*. This was unfortunately not successful, and following this performance she returned to Paris where she continued her studies with Mathilde Marchesi, though she still also did not seem to find her technique with Marchesi, as her debut in La Scala in 1887 was again unsuccessful. She returned to Paris yet again and found a new teacher, this time Rosine Labord, and finally gained her technique. In 1890, she sang the role of Ophélie in Thomas's *Hamlet*, in Teatro San Carlo and La Scala, to great success. In 1891 and 1892, she sang in the Opéra-comique the two roles that she would become most associated with – Carmen and Santuzza – and she would later go on to sing these roles in the Metropolitan Opera in New York. She was iconic in her native France and well-loved in the United States, where she performed in the Metropolitan Opera for nine seasons until 1904. Starting in the 1920s, she only occasionally sang in public, with her last public appearance in 1938.

She was recorded between 1902 and 1919, for the Gramophone & Typewriter Company (London), Victor (New York), and Pathé (Paris). Calvé described her own range as being from *a* to *f*'", though the highest recording I have found of her is only up to *c#*'". Known for her dramatic capabilities, her acting was compared to the great actresses Sarah Bernhardt and Eleonora Duse.[8] Calvé also wrote memoirs: *My Life* (1922) and *Sous tous les ciels j'ai chanté* (1939), describing her journey of coming from a small town in the French countryside, travelling to Paris to study singing seriously, the early failures in her career, and her later successes. These memoirs are how we have the story of her experience with Mustafà.

In Mabel Wagnalls' *Stars of the Opera*, Wagnalls relates an interview with Calvé. She describes New York's fascination with Calvé's Carmen, who was much more powerful and self-assured than previous characterizations of the role seen in New York.[9] Wagnalls describes some of the questions she asked Calvé, and the ones about her voice offer another testimony of Calvé's humming practice:

> When asked if she practices her voice much during the day, Mme. Calvé shook her head.
> "No—not now. You see, I must have mercy on my poor voice and save it for the evenings when I sing. Formerly, of course, I practiced every day, but never more than an hour with full voice. Yes, an hour at one time, once a day, that is all. But I studied much besides. At first I wanted to be an actress, and for this purpose gave much time to dramatic art. My mother was a fine musician; she is the one who urged me to sing."
> "What did you practice when you first began with the voice?—single tones?"

[8] Weber, "Calvé, Emma."
[9] Wagnalls, *Stars of the Opera*.

Mme. Calvé looked thoughtful—she could hardly recall, until a friend who was present suggested—"it was rather intervals and arpeggios, n'est ce pas?" then the great Carmen quickly nodded.

"Yes—you are right; intervals at first, and not until later on, sustained tones. I do not consider single sustained tones good for the beginner."

In reply to a question about breathing, she answered:

"Oh, yes; all singers must practice special exercises for the breath. What else did I do? Well, I hardly remember. I never had any trouble with my throat or my tongue,—no, I never thought much of these."

She was then asked, by way of suggestion:

"Did you ever *hum* in your practice?"

Now her face lighted up.

"Yes," she replied, all animation, "and, do you know, that is splendid! I do it a great deal even yet, especially for the high tones like this"——, and there and then, without moving a muscle, like a conjurer materializing a flock of birds, she showered upon us a bevy of humming-tones. They were soft, of course, but clear and perfect as tho made with full voice, and you wanted to wrap each one in cotton and take it home. But—they were gone!—and the singer went on speaking.

"With Mme. Marchese I used to hum a great deal. Yes, it is an excellent practice, for it brings the tone forward right here," and she touched the bridge of her nose.[10]

The description of these tones is quite interesting: the comparison to a "flock of birds," the mention that they were "soft, of course, but clear and perfect," the desire to wrap them up in cotton, all point to these tones as being delicate, soft and precious, to these high tones that Calvé learned with Mustafà. Calvé seems rather bored in her responses up until the question about humming. That Calvé became animated in talking about these high, humming tones. It is surprising that Marchesi is the teacher mentioned and not Mustafà, though perhaps this was an assumption of Wagnalls, as Marchesi was Calvé's most famous teacher. Humming in general could have been a method Marchesi used with Calvé, but it sounds much more like what she learned with Mustafà, and the excitement that she exhibits on this subject echoes the excited tone of her story about him.

The one recording of Emma Calvé where she sings employs one of these high notes is in the folk song "Ma Lisette," which she recorded in 1908. She jumps up to a *c#'''* at the very end of the piece and holds it for an impressive 10 seconds.[11] This note is quiet and delicate, and one could say that it has the "superhuman, uncanny" quality that she heard in Mustafà's voice as well. Throughout the recording, Calvé's voice has a consistent fast, low amplitude vibrato, and it sounds like this vibrato is still present in this high note, though it is almost inaudible. The vibrato seems more perceptible at certain moments than others, and is most

[10] Wagnalls, 105.
[11] Calvé, *Ma Lisette*.

audible right as she makes the octave leap and towards the end of the note. This vibrato and the general consistency of this delicate pianissimo sound, demonstrate Calvé's strong technique in general, as well as her mastery of the art of these specific high notes. In my own singing, I have not fully mastered these notes so as to be able to produce such a pianissimo, but I have at least worked on them enough that, while they are perhaps quite loud and piercing, they are not wholly unpleasant.

On Anat's Bench

While I have always been a soprano, before going to Dr. Keidar, I was unable so sing notes above the top of the treble staff with any ease. Occasionally I would be able to sing *a"* or even *b"*, but I never felt secure in those notes, and would kind of close my eyes and hope they came out right. I began to wonder if I was really a mezzo because I seemed incapable of singing the high notes expected of sopranos. When I went to Dr. Keidar, she started me over on my technique. In the first few lessons, she did not allow me to open my mouth, requiring that I only hum notes. To my surprise, I was able to hum much higher than I ever had been able to reach singing. In addition to this, and in a departure from the method described by Calvé, Dr. Keidar introduced a method that allowed me to hum even higher. If I placed my fingers in the space between my hyoid bone and thyroid cartilage to keep them apart while I was humming, I was able to add a further few notes to the top of my range.

The process took a couple years, and involved fixing many other aspects of my technique, but at the end of around two years I had useable notes in the whistle/flageolet register. It would have perhaps taken less time if I was not trying to unlearn technical habits that I had engrained over the course of 10 years of previous voice lessons, and if I was not so depressed that I had trouble making myself do anything, let alone practice singing when I also truly sounded like a "miauling cat." I am now relatively consistent in being able to sing up to *f"'*, or *g"'* when I am holding my larynx to keep the hyoid bone and thyroid cartilage separated. The highest sound that my folds ever produced was *c"""*, but that was only one time, and would not have been possible without holding my larynx. As I get older, the top notes available to me are slowly becoming slightly lower, and I doubt I will ever be able again to produce the *c"""* note. (Though of course if I think I will never produce it, this may be enough of a barrier to making it happen, even if it is still physically possible for me.) Because these extreme high notes are not useful for early music, I have not taken the time to continue to cultivate and develop them. I am not able to sing them "very gently" like Calvé. But I

could sing up to *e'"* in a concert setting, which is almost an extra octave over what I would sing in a concert before going to Dr. Keidar.

Before going to Dr. Keidar, it was impossible for me to imagine singing so high. Learning how to sing the highest potential notes in my range made me realize that I always had the potential to sing these notes, it was only a matter of figuring out how. The ruby slippers had always been on my feet. That in turn has made me feel like most people probably have the physical ability to sing higher than they do, it is just a matter of figuring out how. Not all people who can sing in the whistle register have necessarily been taught this skill: in a study examining the purpose of the whistle register, of the twelve subjects, all of whom could sing in that register, four were untrained.[12]

Anat's method was very similar to Mustafà's, but with a few extra tools. I mentioned how she would have me place my fingers between my hyoid bone and thyroid cartilage, but even before doing this, she had me learn how to "reset," how to lower my larynx and raise my soft palate simultaneously (as these motions are connected), and to do this while not engaging the constrictor muscles at the base of my tongue to depress the larynx. She had me put one hand on my larynx, with one finger on each side, in between the hyoid bone and thyroid cartilage, and the thumb of my other hand on the underside of my chin to ensure that the constrictor muscles were not activating, and then had me breathe in, dropping the larynx and maximizing the space between the hyoid bone and thyroid cartilage without engaging the constrictor muscles. All of this was without phonation, it was only to learn this "reset" movement. This exercise took me about two weeks to master, standing on subway platforms and experimenting with movements, slowly making the movements that I thought I was producing to be the same as the movements that I could feel externally.

The humming that she had me do was a very specific type, which she called a "chipmunk." I would stick out my tongue and bite down on it to prevent it from contracting and getting in the way, and then produce a very nasal hum that actually raised the larynx and closed down the space between the hyoid bone and thyroid cartilage. To access the very highest notes, I would have my fingers in this space to prevent it from fully closing down. I would also take a breath and "reset" the larynx position before doing an arpeggio up to the highest notes, allowing that space to open up so I could more effectively lodge my fingers there. After a few weeks, I had mastered these high notes on the chipmunk, but opening my mouth and having the notes sound was another matter. It was partially psychological: I was

[12] Garnier et al., "Glottal Behavior in the High Soprano Range and the Transition to the Whistle Register."

still afraid of high notes, of how much sound they made, the way they felt uncontrollable, the fear that they would crack and the crack would be so exposed because the notes were so high and loud. But it was also that I needed to work on certain other aspects of my technique.

The chipmunk sound also had the benefit of maintaining good adduction. I had MTD, muscle tension dysphonia, with the "slit" rather than the "V" pathology (again, Anat's terms), meaning that my vocal folds had incomplete closure due to the folds being blown apart by too much subglottal pressure, rather than the folds not meeting due to the lateral cricoarytenoid muscle and interarytenoid muscle not bringing them together. I was able to have good adduction with the chipmunk, but when I would open my mouth, the air would come back into the sound. Once I mastered the higher notes in the chipmunk, it was actually those notes first that had good adduction (notes starting at *a"* or so and above), rather than the notes in the middle of the treble staff. I had only rarely used notes above *a"*, and so in this area of my voice I had no previous associations about how to sing, no bad habits to break, so it was easier to have good adduction from the beginning. Additionally, it is more necessary in this range to have good adduction to in order to be able to produce a sound at all. For these reasons, Anat used training the high notes in my voice as a first step towards working on the lower part of my range.

I gradually gained more confidence in these notes, and slowly, like for Emma Calvé, they became more stable and consistent in my voice. These high notes had a lot of power, and singing them helped me to believe in my ability to make changes in and improve my vocal technique. Because what was powerful for me with these notes was not actually that I needed to use them in repertoire so much (though they do come in handy occasionally – for instance in singing the role of Orazio in *Muzio Scevola*, or Hildegard chants), but rather to show me the possibilities of my voice, that I had so much more potential that I had previously imagined in this upper register. By working on this range, my voice became much more physical to me, rather than something mental or disembodied, which it can be easy for a voice to seem, and I was able to take my success in these upper notes as a sign that I could tackle other aspects of my technique.

What is the whistle register?

The whistle register has many names in the literature: flageolet, piccolo, flute, bell register, to name some.[13] In the traditional explanation of the mechanism of the whistle

[13] Miller, *Training Soprano Voices*, 136.

register, the vocal folds experience "damping," where the posterior section of the vocal folds is stiffened does not vibrate, and only the anterior portion of the folds is involved in phonation. As there is less mass involved in vibration, the folds are able to reach a higher pitch than would have been produced otherwise.[14] According to Richard Miller, the whistle register begins at around *a"* for contraltos, *b"* or *c"'* for mezzo-sopranos, and *d"'* for sopranos.[15] In terms of the upper extension, the soubrette, coloratura, light lyric soprano may go up to *g"'*, some light sopranos can do *b"'* or *c"''*, and in rare cases even *c"''''*.[16] Janice Chapman give similar transition points for the transition into the whistle register.[17] Miller states that the top pitches of the soprano range cannot be produced without damping.[18]

However, there is some dispute in the scientific literature about the mechanism of the whistle register. There is a theory that in this register the vibration of the vocal folds is due to turbulent airflow, rather than the vibration of the folds themselves. There is also a question as to whether damping is always involved in producing these high notes, or whether the full length of the vocal folds is vibrating. One of the reasons that the mechanism is still in dispute is because it is so difficult to see, as the vibration rate is too high to be captured by almost any video equipment. There are a few experiments that have been done with high-speed digital imaging (HSDI), using 10,000 or 20,000 frames/second, but they often involve only a few subjects. There are a couple papers worth mentioning here on the subject of the whistle register which can help illuminate the mechanism.

First, it is perhaps best to mention some general information about registers and their definitions. The terms for registers abound, and it is often confusing because different people can mean different things with the terms. Register divisions can be based on what is happening on a laryngeal level, proprioceptive factors including where the resonance is felt in the body, or also acoustical factors. These definitions of registers can overlap. One often-cited study from 2009 entitled "Laryngeal Vibratory Mechanisms: The Notion of Vocal Register Revisited" by Roubeau et al. explores the different mechanisms of vocal fold vibration, and how these mechanisms line up with vocal registers. The researchers used EEG (electroglottography) to measure how the vocal folds are meeting. In EEG, a current is passed through electrodes that are placed on the larynx. Electricity is passed through these electrodes, which is conducted through the meeting of the vocal folds and disrupted by air

[14] Miller, *Solutions for Singers: Tools for Performers and Teachers*, 61.
[15] Miller, *Training Soprano Voices*, 25.
[16] Miller, 137–38.
[17] Chapman, *Singing and Teaching Singing*.
[18] Miller, *Solutions for Singers: Tools for Performers and Teachers*, 61.

between them. The conduction or disruption of the current can be measured, providing a signal reading that is a representation of how the folds are meeting. Using EEG, four different mechanisms were identified by Roubeau et al., with four different EEG signals: M0, M1, M2, and M3, corresponding roughly to vocal fry, chest voice, head voice, and whistle register, respectively.[19] The EEG readings in the M2-M3 transition show a change in the signal, suggesting that there is a different amount of contact between the folds and therefore a different laryngeal mechanism, one that is specific to the highest notes in the voice: this M3 laryngeal mechanism is what we are interested in here, as it is the highest register of the voice in terms of laryngeal mechanisms. Another paper by Garnier et al. further examines the M2-M3 transition in professional singers, advanced students, and amateurs, and identifies the shift as occurring between *d#''-d'''*, over the course of several notes. The pitch over which the transition was completed was higher for trained than untrained sopranos.[20] These results are surprising as this transition is given as occurring at *d'''* by Richard Miller in sopranos, and so *d#''* seems so low for this transition to occur, though perhaps with training this transition would occur higher.

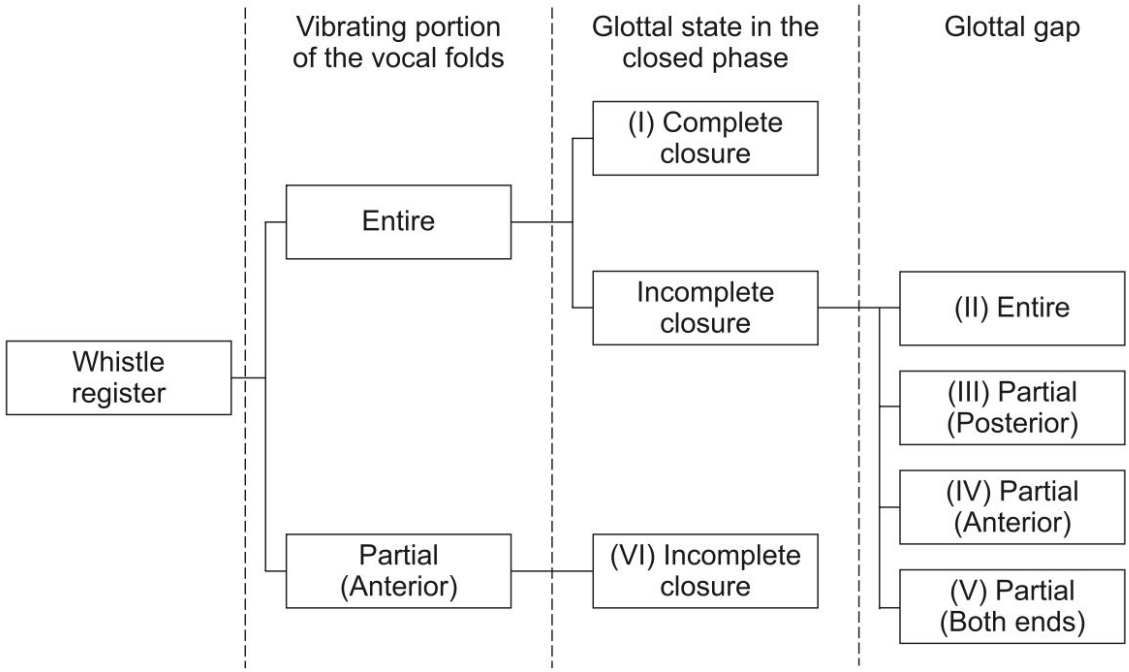
A 2013 paper by Echternach et al. investigates the question of whether "damping" is taking place at all. The researchers observed a professional soprano, using HSDI at a frame rate of 20,000 frames/s to see if the vocal folds were using damping, or if they were vibrating along their whole length. They found that in fact the whole length of the vocal folds were vibrating for these high notes, up to 1568 Hz (*g'''*). The authors thus reject the idea that she used a whistle register or flageolet mechanism, and say there was no observable difference between the vibration in the highest notes in comparison with other head voice notes. However, they do also mention that the singer nevertheless still experienced a "register shift" at around *e'''* or *d'''* that was associated with the narrowing of the laryngeal walls, though not any events within the larynx.[21]

Another HSDI study from 2016 by Di Corcia and Fussi[22] on the whistle register looked at 39 subjects, both male and female, who they had trained to use whistle tones. The level of training of these subjects was unclear. The researchers explored two different mechanisms for singing high notes, one was the Female Laryngeal Whistle (FLW) and the other was the Stop Closure Whistle (SCW). In the FLW, the whole length of the vocal folds

[19] Roubeau, Henrich, and Castellengo, "Laryngeal Vibratory Mechanisms."
[20] Garnier et al., "Glottal Behavior in the High Soprano Range and the Transition to the Whistle Register."
[21] Echternach et al., "Vocal Fold Vibrations at High Soprano Fundamental Frequencies."
[22] Di Corcia and Fussi, "Whistle Register and M3: A Preliminary HSDI Investigation by Visualization and Acoustics in Male and Female Singers."

vibrated, while the SCW involved damping. In women subjects, the average range of FLW was *g*'' to *d*''', and for SCW, the range was from *c*'' to *e*''' in women and *a*' to *e*''' in men. It is interesting that the SCW can extend so low.

A different study from 2023 by Kato et al. aimed to better understand the mechanism of the whistle register by using HSDI at a rate of 10,000 frames/second. The study examined six subjects: four women and two men, the second of whom (M2) was using inspiratory phonation. The researchers observed six different phonation patterns, summarized below (Figure 1 in the paper):



The traditional explanation of whistle register with damping corresponds to vocal fold vibration type VI, while the other types involve the vibration of the whole length of the vocal folds. Types III, IV and V are new mechanisms. Below is the chart of the samples taken for each subject, classified according to the type of vocal fold vibration (Table 2 of the paper):

TABLE 2.
Number of Data Samples for Each Subject and the Target Pitch

Subject	D6	E6	F6	F6♯	G6	A6	Total
F1		1 (IV)	4 (I, II, II, IV)	2 (I, II)	3 (I, II, II)		10
F2			1 (III)	1 (II)	2 (I, II)		4
F3	1 (II)	1 (II)	1 (II)		3 (II, II, V)		6
F4				1 (VI)			1
M1						2 (I, I)	2
M2		1 (VI)	2 (VI, VI)		1 (VI)	1 (VI)	5
Total	1	3	8	4	9	3	28

Notes: Each Roman number indicates the type of vocal fold vibration, as explained later in Results.

Only two of the subjects sang with the VI type, the type described as the whistle register mechanism by Richard Miller. The others used vibration along the full vocal folds, with

complete, entirely incomplete, or partially incomplete closure. These vibratory patterns are different from a head voice or falsetto production, and so the researchers posit that the whistle register is not just an extension of the falsetto register.

This study suggests a multiplicity in the possibilities of whistle register mechanism, that there is not only one way of producing high notes. I would be curious to be able to hear the difference between the samples, to know how the different phonatory mechanisms actually sound, and if it is possible to hear a difference between them. It would be interesting to see if some of the sounds are better suited to operatic repertoire than others.

It is possible that this type VI vocal fold vibration type is the sort of fluty, otherworldly sound used by Calvé and Mustafà, but that the other types, where the full length of the folds are meeting, have a different sort of sound that is associated with the operatic repertoire of today. Classical technique emphasizes a unity of the registers, and when I listen to modern opera singers even the highest notes do not necessarily sound like a completely different register. However, without access to a laryngoscope, it seems like it would not be possible to tell definitively which mechanism was being used.

Another recent study, available in a preliminary form because it has yet to be peer-reviewed, by Echternach et al. may shed even more light on the subject of the whistle register. Entitled, "Biomechanical sound production in high-pitched classical singing – the 'Queen of the Night' does not whistle," the paper shows that the aerodynamic whistle mechanism model for the whistle register is not valid. One of the authors on the paper is Ingo Titze, who had earlier described this possible his aerodynamic model in his textbook *Principles of Voice Production*.[23] The study uses HSDI footage to understand the whistle register mechanism in 9 sopranos, of which four had incomplete glottal closure (glottal configuration I), corresponding to the damping mechanism, and five had complete glottal closure in the closed phase. Of those with complete glottal closure, three had only partial opening in the open phase (glottal configuration IIa) and two had a fully opened visible glottis in the open phase (glottal configuration IIb). Like in Kato et al., there are subcategories for when there is full glottal closure along the folds, though this paper did not note so many subcategories.[24]

While Richard Miller buys into the damping mechanism for the whistle register, he also recognizes that even though the whistle register, "produces a quality somewhat different

[23] Kato et al., "Vocal Fold Vibration of the Whistle Register Observed by High-Speed Digital Imaging."
[24] Echternach et al., "Biomechanical Sound Production in High-Pitched Classical Singing the 'Queen of the Night' Does Not Whistle."

from conventional head voice…flageolet is simply an extension of head voice."[25] While flageolet is not necessarily an extension of head voice (further research is needed in the field to be able to make this statement definitively), it is also perhaps not so far from head voice as previous research has suggested.

The research is not definitive about the mechanism of the whistle register. All the studies are quite small, and they are difficult to compare with each other, and they each have their own problematic issues. For instance, the study by Di Corcia and Fussi, they say that they taught their participants to use this register. If this is so, then none of these participants could yet be an expert in this way of singing, which seems like it would make it difficult to get consistent sound samples and readings. The study by Echternach et al. in 2013 involved only one singer. The Echternach et al. study that was released preliminarily in 2023 has yet to be peer reviewed. The Kato et al. study involved only six subjects, of which one was using inspiratory phonation, which is not relevant to a normal singing technique.

That the research is in such an open state was surprising to find. That the two most exciting and relevant papers are so recent, both from 2023, gives hope that the voice science community recognizes this hole in the research and is eager to pursue it. But what do we now do with this term, "whistle register"? Titles like "The 'Queen of the Night' does not whistle" calls exactly this into question. The M3 register observed by Roubeau et al. suggests some sort of change in the laryngeal mechanism of phonation, but is it a whistle? I suppose this is a matter of definition. If the "whistle" register is defined as using the same mechanism as a regular whistle with the lips, then no, none of the papers I found seems to support this. If it is defined as using damping, then it seems that sometimes high notes are produced this way, and sometimes not. If it is defined as the M3 register shift (as defined by the EEG readings), then further research is required that compares the EEG readings to the HSDI findings. The M3 register change was often happening lower than the where this shift into the whistle register is usually given in the literature on teaching singing. Again, it is frustrating to not have audio samples with these experiments, as it would be nice to hear the sounds that correspond to the differences in mechanism.

This research has made me question my understanding of the nature of the highest notes in my own voice. Am I using damping? What causes me to feel this change in register? Am I sometimes employing damping, sometimes not? If I had to guess, I would say that it is likely that the entirety of my folds is vibrating, which I would surmise for two reasons: that

[25] Miller, *Solutions for Singers: Tools for Performers and Teachers*.

sometimes I do not feel a significant register shift, and that when I do feel it, it is more like a break (like between chest and head voice) rather than a big change in timbre; and the second reason is that there is not a great difference in the sound production between the notes on either side of this shift, which is usually around *c'''* or *d'''*. However, sometimes it does feel like these highest notes are easier, like there is some change in the way my folds are vibrating, which could point to damping. But this is all speculatory, and not possible to confirm without laryngoscopy.

These discoveries also complicate the terminology for this paper. Going forward, we will still use the term whistle register to talk about these highest notes of the voice, with the recognition that in the future, this term may come to mean something much more specific, or that it already to some does mean something more specific to certain people. I will, however, begin to incorporate some speculation as to the production of these highest notes in the voice. It seems likely to me that the damping method of singing of these notes would be quieter, while the method where the full folds vibrate would be louder, and I will speculate more on this over the course of this paper, as I put forth several case studies.

A 19th-Century Voice Scientist on the Whistle Register: Emma Seiler

There are two 19th-century tomes that deal with the whistle register, one being *The Voice in Singing* by Emma Seiler, published in 1866. Seiler uses a laryngoscope[26] to examine her own voice and those of others. In the preface materials to Seiler's book, Professor E. Du Bois-Reymond provides a testimonial in which he shares that, "she appears especially to have brought to a final and satisfactory decision the much-vexed question respecting the

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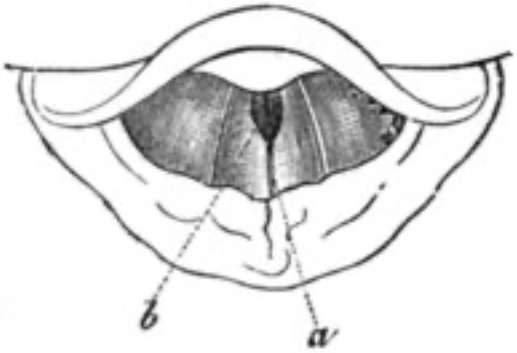
[26] Seiler and Furness, *The Voice in Singing*, 39–40. Seiler's description of the laryngoscope is a fascinating window into 19th-century science, and is as follows: "The laryngoscope is well known among medical men. It is a small plane mirror of glass or metal, having a long handle. Before it is introduced into the throat, it is first warmed, to prevent its becoming dimmed. The reflecting surface of this instrument is directed downwards and forwards, so that it receives the reflection caught from a concave mirror, and presents to the eye of the observer a picture of the illuminated larynx. In using it upon oneself, there is need of a second mirror, which must be so held that the image may be seen in the laryngoscope. The use of the laryngoscope requires in the observer a certain adroitness and long-continued practice almost more in the observer than in the subject of observation. In self-observation one must first learn to overcome the irritation always caused at the first by the contact of the mirror with the back of the throat. Once accustomed to the contact, one soon succeeds in obtaining a sight of the larynx, sufficient for the most part for pathological purposes. But it requires long practice before one can control those organs, usually not immediately submissive to the will, and raise the epiglottis, so as to be able to see into the whole larynx. But this is absolutely indispensable, in the observation of the formation of sound, to the attainment of any substantial results. Garcia says himself that *one third of the glottis* was always *hidden* from him by the epiglottis, and to this circumstance is the unsatisfactory character of his observations to be ascribed. But even when, after long practice, one is able at last to bring the whole glottis into view, this is not by any means enough. Not until observation has been so long continued that all the movements of the vocal organ are normal, notwithstanding the unnatural drawing back of the epiglottis, and not until the process that goes on is found again and again to be always the same, can it be recognized as fact."

formation of the so-called *fistel tones* (head tones)." For Seiler, the "head tones" or the "head register" are the whistle register, rather than the head voice, as she uses the term "falsetto" to mean what is now commonly referred to as head voice. Seiler describes how she noticed a change in the timbre of her voice from *f#"*, and that she then used the laryngoscope to observe her own vocal folds. She provides a diagram and description:



Representation in the mirror of the organ of singing in the formation of head tones.
a. The closing together of the vocal ligaments.
b. Open part of the glottis….

The foremost part of the glottis formed an oval orifice, which, with each higher tone, seemed to contract more and more, and so became smaller and rounder. The fine edges of the vocal ligaments which formed this orifice were alone vibrating, and the vibrations seemed at first looser, but, with every higher tone, the ligaments were more stretched. The larynx remained in its natural state.[27]

Seiler's description matches with the damping mechanism, or vocal fold vibration type VI from the Kato et al. study. It is fascinating that Seiler locates this shift on *f#"*, far below where most vocal pedagogues locate it.

As Seiler describes herself, she was at first reluctant to publish her findings about the "head tones" mechanism, because many other scientists had already proposed mechanisms that were different from hers, and some even denied its existence. Her initial attempts to put forward her theories were dismissed, and while she at first took this to heart, she later went back to her own observations and she remained convinced that she was correct, even though she did not know of any anatomical work that supported her findings.[28] Seiler's work was well regarded in her day, and in Emil Behnke's *The Mechanism of the Human Voice*, he relied almost entirely on Seiler's description of "head tones" and their mechanism (though instead of using the term "head tones" he uses "small register").[29]

[27] Seiler and Furness, 58–59.
[28] Seiler and Furness, 59–60.
[29] Behnke, *The Mechanism of the Human Voice*.

Seiler was also a voice pedagogue in addition to a researcher, and her book has information that is oriented towards practice and teaching. She says the following about the "head register":

> The head register possesses a very great capacity of expansion, which, without the slightest straining, may be gradually extended, with some practice, a whole octave, and often even still farther upwards. When the transition is made from the highest tones of the falsetto register to the head register, there is experienced the same sense of relief in the organs of singing as in passing from the chest to the falsetto register. And this is very easy to be understood, because the ligaments by this repeated partial closure of the glottis are much less stretched than in the highest tones of the preceding lower register. The difference in sound between the highest tones of the falsetto and head registers is often slight, on which account these two registers, so different in their mechanism, are easily confounded. Only in entirely healthy vocal organs can the head tones be observed. A too great secretion of mucus, or any inflammation of the mucous membrane, embarrasses the formation of head and falsetto tones, while the vibrations of the fine edges of the vocal ligaments are thereby obstructed. The character of the vocal organ fully explains why in the case of sick or of worn-out voices it is always the high tones that are first lost…
>
> When one sings the scale, note by note downwards, one can sing with the action of the higher register many of the tones of the lower, without any observable straining of the organ; indeed, there is a perceptible feeling of relief; only these tones are not so full as when sung in their natural register.[30]

The extension of the "head register" up to an octave or more above where she transitions on *f#*" aligns with the extension of the whistle register described by Richard Miller, even if this transition point on *f#"* is so low. She further says that this transition point can be brought even lower, a finding also supported in Garnier et al. The relief that she experiences in transitioning into the "head register" is quite interesting, and I do sometimes feel this as well in my own voice, which could be an argument that I am using this mechanism in my own voice too, rather than the full-fold vibration method. That she describes the sound of highest notes of the falsetto and head register as not so different to one another seems rather perplexing, though she does admit that the head tones are "not so full" as they would be if they were in falsetto. With both the description of physical relief and the sound of the highest notes being similar, she seems to be advocating for the more widespread use of this register, perhaps because it is something that she feels she discovered.

Seiler's study and writings show that there was an awareness of and interest in this register above head voice even in the 19th century. That Emma Calvé had not heard of it

[30] Seiler and Furness, *The Voice in Singing*, 60.

before hearing Mustafà suggests that perhaps it was not so well known, or that it was known amongst the scientific community interested in the voice, but not amongst vocal pedagogues. This divide between the science and musical communities in the 19th century echoes the divide that we see today. However, it could have also been a question of the aesthetic tastes of the time, and perhaps the musical tastes did not in general favor the sound of this whistle register with damping.

How do other modern teachers try to develop the highest notes?

There are certainly other methods for teaching this upper register than the one used by Mustafà, or the method used by Dr. Keidar, though humming or closed voiced consonants seem to play an important part in most of the methods. In *Singing and Teaching Singing*, Janice Chapman suggests that, "Using a good supported airstream and a rolled 'rr' scale, the upper whistle register can be easily connected to the top of the head voice and further practiced into normal singing."[31] This is also something that I have done with my own students, to good effect. I often will try to teach with the "chipmunk" sound that Anat taught me, but I find that it can be difficult for my students to find this sound. A rolled r, or another voiced consonant, like the hum suggested by Mustafà, can often be easier, especially for beginners.

Richard Miller devotes a section of *Training Soprano Voices* to the whistle register, recommending, "a few additional minutes spent drilling flageolet register should be part of the daily technical routine, regardless of fach."[32] He emphasizes how students should be given exercises to explore and master their whole range. For Miller, because this register is needed for performing the highest notes in the repertoire, it is vital for it to be trained, especially in those sopranos who will need it, but also for mezzos and even contraltos, as training it gives them access to their full voice.

In terms of how to learn it, Miller suggests, "Flageolet timbre is best accomplished in an almost childlike manner, executing rapid patterns imitative of hilarious laughter." He continues:

> Have the student imitate light, high, laughter, repeated a number of times. Teacher and student should join together in such hilarity. Equally useful is the imitation of a rapid siren sound, from low to high range, aiming at no specific pitch; at each repetition the glissando motif is tossed higher and higher…. A singer must be willing to cast aside all reserve and enter into a spirit of utter abandonment.[33]

[31] Chapman, *Singing and Teaching Singing*, 80.
[32] Miller, *Training Soprano Voices*, 138.
[33] Miller, 137.

The childlike quality can be helpful for finding the fluty sound, but the emphasis on play is also helpful not only for finding the mechanism but also for producing these notes, as it can take away some of the fear of singing them. I found in my students, if I can get them to think of these notes as noises rather than singing, it is easier for them to make these sorts of sounds. (This was also certainly true for myself when I was learning.) Miller's suggestions of light laughter and sirens are just the sorts of sounds I have found to be effective, and the laughter has the additional benefit of activating a natural breath support conducive to producing these notes. In addition to these more abstract exercises, Miller also recommends working on particular passages from repertoire that involves these high notes, for instance the roles of Gilda, the Queen of the Night, Blöndchen, Constanze, Titania, Violetta, and Leonora from *Il trovatore*.[34] Miller provides this optimistic comment, "Almost every female, with the possible exception of the true contralto, can learn to produce sound in flageolet range."[35] It is at the very least worth exploring this register for all female students, if only so that the student can experience the full potential of their own voice.

Case Studies of Individual Singers

The following case studies represent a few instances of individuals who could sing extraordinarily high. The singers mentioned here are Matteo Berselli, a castrato with a particularly high voice; a girl from Venice described by Charles Burney; Lucrezia Aguiari, who wowed both Wolfgang and Leopold Mozart; Aloysia Weber, for whom Mozart wrote his highest arias; Lily Pons, the 20th century opera star who is perhaps a little late to consider here, but nevertheless had a sound reminiscent of the earliest recordings and spectacular technique in her high notes; and Lilli Lehmann, who, while not possessed of a particularly high voice, could also sing up to *f'''* at least, and is also included here for her description of these notes in her book *How to Sing*.

Matteo Berselli

The castrato Matteo Berselli is described by Quantz as having an extraordinary range and can provide us with an example of a castrato who perhaps had access to the whistle register. Berselli was an Italian soprano castrato, active 1708-21. Apparently originally from

[34] Miller, 138–43.
[35] Miller, *Solutions for Singers: Tools for Performers and Teachers*.

Venice, he sang throughout Italy as well as in Dresden and London, working with some of the leading composers of the day including Gasparini, Lotti, Bononcini and Handel. Handel composed the role of Orazio in *Muzio Scevola* for him, as well as the role of Tigrane in *Radamisto*.[36]

> Quantz's description is from his autobiography, and is as follows:
>
> Berselli had a pleasant, yet somewhat thin, high soprano voice, whose range extended from *c'* to the *f'''* with the greatest ease. This caused the audience more astonishment than the art of his singing. In the Adagio, he showed little affect, and in the Allegro he did not allow himself to fall into passagework. His figure was not bad, though his stage presence was not fiery.[37]

The fact that audiences were astonished by such a range shows that it was rare. Quantz's tone in this excerpt is quite lukewarm about Berselli and his singing: except for Berselli's extraordinary range and his "not bad" figure, both gifts that Berselli may have had and not had to work for, Quantz describes his voice as "pleasant, yet somewhat thin," and takes aim at his singing of fast and slow arias as well as his general stage presence. This seems to imply that for Quantz at least, this extraordinary range was a secondary consideration to more important artistic traits, like the ability to move the passions in Adagios or to do coloratura passagework in fast arias, or the possession of a powerful stage presence.

The example of Berselli's character of Orazio in *Muzio Scevola* by Filippo Amadei, Bononcini and Handel provides a unique example of a baroque opera where we can see how different composers write for the same singer in the same character. The writing can show the abilities and strengths of the singer, and how the composers did or did not take advantage of these abilities. It can give an idea as to where the voice naturally lies, particularly by looking atthe recits. In *Muzio Scevola*, the recits for the role of Orazio all sit rather high, usually in the *f'-f''* range, with the occasional *e'*. The arias written for this character also do not go low, with only the occasional *d'* in some places. Only the Bononcini arias takes advantage of Berselli's high notes, with "Scioglesi la procella" ascending to *d'''*. Amadei regularly keeps the highest notes to *g''*, and Handel too only goes up to *a''* in the one aria he wrote for this character, "Come, se ti vedro." However, it is also interesting that this aria has six cadence moments that can be embellished, leading Burney to remark that "This singer must have been high in

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[36] Dean, "Berselli, Matteo."

[37] Translation my own: Berselli hatte eine angenehme, doch etwas dünne, hohe Sopranstimme, deren Umfang sich vom eingestrichenen c, bis ins dreygestrichene f, mit der größten Leichtikeit erstreckte. Hierdurch feßte er die Zuhörer mehr in Verwunderung, als durch die Kunst des Singens. Im Adagio zeigte er wenig Affect, und im Allegro ließ er sich nicht fiel in Passagien ein. Seine Gestalt war nicht widrig, die Action aber auch nicht feurig. From Michtner, *Das Alte Burgtheater Als Opernbühne, von Der Einführung Des Deutschen Singspiels (1778) Bis Zum Tod Kaiser Leopolds II. (1792)*, 272.

the composer's favour for taste, as he is left to himself in no less than six *ad libitums* and adagios, which he had to embellish."[38] That the recits were all written rather high and that there were very few examples of *d'* or *e'* in these pieces suggest that Berselli's voice sat rather high, and may have been weak in his low range. It is surprising that Amadei and Handel do not take advantage of this high range, given that Bononcini does, but perhaps it had to do with the conventions and priorities of the time. Text surely gets more difficult to understand in this upper range. Furthermore, even though Handel did not write higher than an *a"* for Berselli, the plethora of *adagio* moments could have provided him with the freedom to show off these upper notes if he pleased.

La Ferrarese

One of the other earlier references to high voice singing is found in Burney's *The Present State of Music in France and Italy*, published in 1771, where he describes one of the orphans in the *Ospedaletto* in Venice: "…one of them, *la Ferrarese*, sung very well, and had a very extraordinary compass of voice, as she was able to reach the highest E of our harpsichords, upon which she could dwell a considerable time, in a fair, natural voice."[39] That Burney says that she had a "very extraordinary compass of voice," again shows that this note was a rarity. If it was a rarity even for him to hear, as he had travelled so much and heard so many things throughout Europe, it was likely quite uncommon at the time. That she could "dwell a considerable time, in a fair, natural voice" on this note also points to the whistle register, perhaps with the damping mechanism giving it a greater sense of ease.

It has been proposed, though not confirmed, that this *La Ferrarese* may have been the singer Adriana Ferrarese del Bene, who later originated the role of Fiordiligi in Mozart's *Cosi fan tutte*. Even though this link is not certain, it is still intriguing to consider. This link was made by Ernst Ludwig Gerber in his *Historisch-Biographisches Lexicon der Tonkünstler*, where he lists her as Francesca Gabrielli, called La Ferrarese. Gerber does not mention Burney in this entry, but he uses almost the same description to describe her voice that Burney does, saying, "Der Umfang ihrer Stimmer erstrechkte sich bis ins dreygestrichene e, welches sie ziemlich lange, in einem reinen und natürlichen Tone, aushalten konnte."[40] (In translation this is: "The range of her voice extended to *e'"*, which she could sustain for quite a long time in a pure and natural tone.") This description is almost identical to Burney's, so that it must have

[38] Burney, *A General History of Music*, 741.
[39] Burney, *The Present State of Music in France and Italy*, 150.
[40] Gerber, *Historish Biographisches Lexicon Der Tonkünstler*, 465.

come from him. Gerber quotes Burney in other parts of his lexicon, and so was using Burney as a source for his own work.[41] Gerber also provides some details about her life, mentioning the moniker La Ferrarese was because she came from Ferrara, and that she studied with Sacchini in the Conservatorio Ospedaletto a Giovanni e Paolo in Venice.[42]

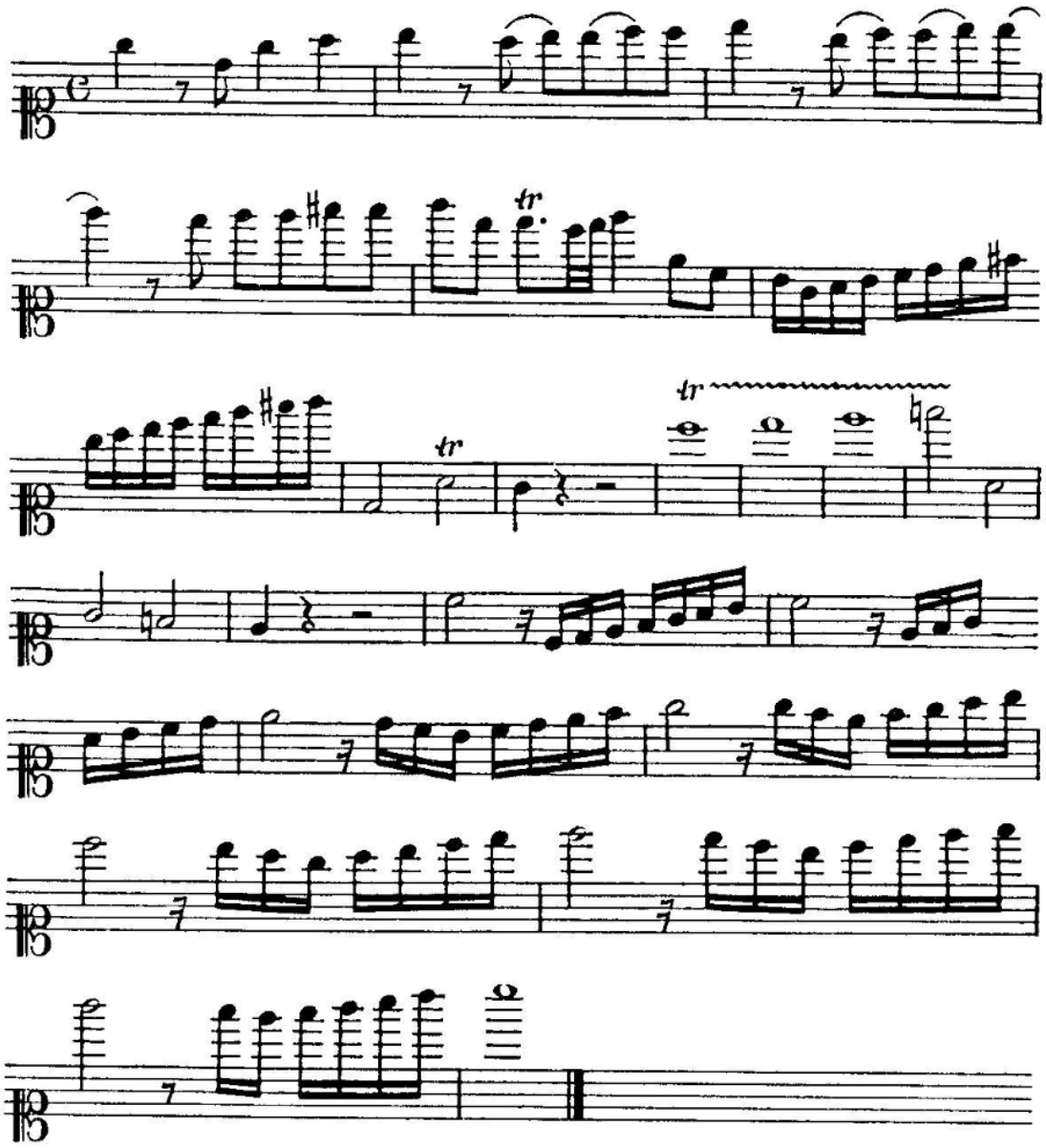
Adriana Ferrarese (1759-1804) did sing with the Ospedale dei Mendicanti in Venice from 1778-1782, then left there to sing in Livorno and London before ending up in Vienna. In Vienna, she began an affair with the librettist Lorenzo da Ponte, who was then at the height of his fame. It was through this tryst that she gained the roles of Fiordiligi (1790) as well as Eurilla in Salieri's *La cifra* (1789). When da Ponte was dismissed, she too left Vienna and returned to work in Italy. In her career, she was often cast in serious roles, even in *opera buffa*, perhaps for the timbre of her voice and character of her singing.

If Burney's La Ferrarese was indeed Adriana Ferrarese, then where did her high notes go later in her career? The role of Fiordiligi goes up to *b"*, and also requires strength in the low *a*. Burney would have heard her in 1770,[43] when she would have been only 10 or 11. Her voice would have changed in adulthood, and perhaps she no longer had this high upper extension by the time she was singing Fiordiligi in 1790.[44] From her time in Vienna, her voice is described by the *Rapport de Wien* as follows: "Sie hat bei einer unglaublichen Höhe eine frappierende Tiefe und Kenner der Musik behaupten, dass seit Menschengedenken in Wiens Mauern keine solche Kehle geklungen hat."[45] (Translation: "It has an astonishing depth at an incredible height and music connoisseurs claim that no throat has sounded like this within Vienna's walls for as long as anyone can remember.") This description could have referred to her notes at the top of the staff, perhaps *g"- b"* (the role of Fiordiligi often requires holding a *bb"* in "Come scoglio,"), which while below the whistle register, are high nonetheless. If it was the same singer, she may have no longer employed these whistle register notes past childhood, or may have lost their ease and thus not used them in performance, in a way similar to what Lilli Lehmann describes, as we will see later.

Lucrezia Aguiari

[41] Gerber, 602.
[42] Gerber, 465.
[43] Gidwitz and Rice, "Ferrarese, Adriana."
[44] Brandenburg, "Ferrarese, Adriana."
[45] Michtner, *Das Alte Burgtheater Als Opernbühne, von Der Einführung Des Deutschen Singspiels (1778) Bis Zum Tod Kaiser Leopolds II. (1792)*, 272.

On March 24, 1770, Wolfgang Amadeus Mozart wrote a letter to his sister in which he mentioned a singer with an extraordinarily high range, "In Parma, we got to know a singer and heard her perform very beautifully in her own house – the famous Bastardella who has (1) a beautiful voice, (2) a marvelous throat, (3) and incredible range. While I was present she sang the following notes and passages:"[46][47]



[46] Anderson, *The Letters of Mozart & His Family*, 179.
[47] Bauer and Deutsch, *Mozart: Briefe Und Aufzeichnungen*, 1:323 24.

This last note is a *c''''* – incredible that she could not only reach this note but sustain it! It is remarkable as well that not only did she have this range and vocal agility, but that Leopold Mozart also found her voice to be beautiful. Leopold Mozart also heard Aguiari sing, and in another letter dated March 24, 1770 written to his wife, he mentions that she has a "good deep alto down to G,"[48] so her voice still had a low range as well, even though she could sing so high. Another section of this letter points to the use of whistle register in particular, "The passages which Wolfgang has written down occurred in her aria and these she sang, it is true, more softly than her deeper notes, but as beautifully as an octave stop in an organ."[49] That these notes were sung more softly, and with the sound of an organ stop, which was perhaps a fluty quality, points to a different register, and perhaps the use of the damping technique involved in the whistle register.

Originally from Ferrara, Lucrezia Aguiari (1743-1783) debuted in Florence in 1764, later giving concerts in Paris and London. When she sang in Parma in 1768, she became a *virtuosa da camera* for the Duke of Parma, and she remained connected to this city for most of her life.[50] She had a personal and professional relationship with the composer Giuseppe Colla, the *maestro* in Parma, and by 1780 they were married.[51] About her singing, Burney mentions, "though the pathetic and tender were not what the matter of figure promised, yet she had expressions sometimes that were truly touching, and she would have been as capable of exciting universal pleasure, as admiration, if she had been a little less violent in the delivery of her passages, and her looks had been more tempered by felt softness and timidity."[52] She seems to have been an excellent musician and technician, even if her dramatic expression may have sometimes been lacking.

Aloysia Weber and the Weber sisters

Some of the highest pieces in the Mozart repertoire were written for Aloysia Weber (1761-1839), in particular the role of Madame Herz in *Der Schauspieldirektor* (which goes to *g'''*); the concert arias KV 294: "Alcandro, lo conser" (up to *e'''*), KV 316: "Popoli de Tessaglia" (up to *g'''*), KV 538: "Ah se in ciel, benigne stelle" (up to *d'''*); and the insertion arias KV 418: "Vorrei spiegarvi, oh Dio" (up to *d'''*) and KV 419: "No, no che non sei capace" (up to *e'''*).

[48] Anderson, *The Letters of Mozart & His Family*, 120.
[49] Anderson, 120.
[50] Gualerzi Pregliasco, "Agujari, Lucrezia," 238.
[51] Kuzmick Hansell, "Aguiari, Lucrezia."
[52] Burney, *A General History of Music*.

That she was going up to *g'"* in both *Der Schauspieldirektor* and "Populi de Tessaglia" demonstrates that she would have needed to employ the whistle register in her singing.

> Leopold Mozart describes her voice as follows in a letter from March 25, 1785:
>
> It can scarcely be denied that she sings with the greatest expression: only now I understand why some persons I frequently asked would say that she has a very weak voice, while others said she has a very loud voice. Both are true. The held notes and all expressive notes are astonishingly loud; the tender moments, the passage-work and embellishments, and high notes are very delicate, so that for my taste the one contrasts too strongly with the other. In an ordinary room the loud notes assault the ear, while in the theatre the delicate passages demand a great attentiveness and stillness on the part of the audience.

This description of the high notes as being "very delicate" goes along with the flute-like quality often used to describe the whistle register notes and points towards her use of the whistle register with damping. Her whistle register range may have had a profoundly different sound than her head voice, though she would have been only 23 or 24 at this time, and perhaps later, like Calvé, she developed these upper notes further.

Aloysia was the sister of Constanze, Mozart's wife, and it was actually Aloysia he fell in love with first, when he taught her in Mannheim in 1777 and 1778. Aloysia Weber's other sister, Josepha also had these high upper notes, and was the original Queen of the Night, a role demanding the ability to sing up to *f'"*.[53] The fact that this role is so prominent in the repertoire, is enough of an argument in itself for the importance of being able to teach access to the whistle register to the sopranos for whom this role lies in their fach. That both these sisters had this whistle register capability also suggests that the ability to sing in the whistle register well is also related to physiological capabilities that are to some extent genetically predetermined, that it is a predisposition that some people may have more than others, rather than that anyone can equally learn it.

Lilli Lehmann

Lilli Lehmann (1848-1929) was a German soprano, who sang a wide variety of repertoire, including Wagner, Verdi, Mozart and Bellini. She came from a musical family and learned singing from a young age. In addition to being a singer, she was well-known as a pedagogue, and in 1902 published a book *Meine Gesangskunst*, translated into English as *How to Sing*.[54] In this volume, she aims to "discuss simply, intelligibly, yet from am scientific point of

[53] Bauman and Corneilson, "Weber, Josepha."
[54] Forbes, "Lehmann, Lilli."

view, the sensations known to us in singing."[55] This book includes a part that discusses high notes, "Section XVIII: The Highest Head Tones":

> As we have already seen, there is almost no limit to the height that can be reached by the pure head tone without admixture of palatal resonance. Very young voices, especially, can reach such heights, for without any strain they possess the necessary adaptability and skill in the adjustment to each other of the larynx, tongue, and pillars of the fauces. A skill that rests on ignorance of the true nature of the phenomenon must be called pure chance, and thus its disappearance is as puzzling to teacher and listener as its appearance had been in the first place. How often is it paired with a total lack of ability to produce anything but the highest head tones! As a general rule such voices have a very short lease of life, because their possessors are exploited as wonders, before they have any conception of the way to use them, of tone, right singing, and of cause and effect in general. An erroneous pressure of the muscles, a wrong movement of the tongue (raising the tip, for instance, ), an attempt to increase the strength of the tone,—all these things extinguish quickly and for all time the wonder-singer's little light.
>
> We Lehmann children in our youth could sing to the very highest pitch. It was nothing for my sister Marie to strike the 4-line *e* a hundred times in succession, and trill on it for a long time. She could have sung in public at the age of seven. But since our voices, through the circumstances of our life and surroundings, were forced to early exertions, they lost their remarkable high notes; yet enough was left to sing the *Queen of Night* (in Mozart's opera "Die Zauberflöte"), with the high *f*.
>
> But one should not suppose that the head tones have no power. When they are properly used, their vibrancy is a substitute for any amount of power.[56]

Lehmann touches on many points that are relevant to questions surrounding the whistle register. Is this ability something learned, or something one can do naturally? In describing her sister and herself, she seems to suggest that these were abilities that they simply had and did not need to learn. However, if they were coming from a musical family and received early exposure to a *bel canto* vocal technique, these notes could have been something that learned from being at home. How does the ability to use these notes change as one ages? Here she suggests that children can easily access these notes, and but over time one loses them. Girls' voices change as well in puberty, just not as noticeably as boys, so it would make sense if this ability was partially lost in adulthood. If *La Ferrarese* was indeed Adrianna Ferrarese, this could have happened to her. That those that have these notes often lose them because they are exploited before they have a solid technique also suggests that with overuse they can be lost, especially in singers who do not have a solid technical foundation, as is often true for singers who have these notes. She and her sister both lost some of their facility with the high notes

[55] Lehmann, *How to Sing*, 1.
[56] Lehmann, 162–63.

through "early exertions," though they were still able to sing the Queen of the Night. Finally, if one can sing these highest notes, does one have the ability to sing low? She says that often these singers do not have this ability, though as we saw with Lucrezia Aguiari, this is not necessarily the case, as she could sing down to *g*.

Lily Pons

Lastly, the example of Lily Pons (1898-1976) is perhaps a little late, but the quality of her high notes is so remarkable, that a paper on high notes in opera would seem remiss without a mention of her. In addition, her technique has an affinity to the earliest recordings, with a clarity of sound and a very fast and narrow vibrato that often seems to characterize the technique from the turn of the 20th century. Pons was a French coloratura soprano who later became American, as her career was largely based in the United States. She began her musical studies as a pianist, and at the age of 15, won the first prize in piano at the Paris Conservatory. She did not start studying singing seriously until she was around 30, at which point she studied with Alberti di Gorostiaga. She debuted as Lakmé in 1928 in Mulhouse, and in 1931 won a contract with Metropolitan Opera in New York, where she stayed for 28 seasons. Her roles included Gilda, Amina, Marie (*La fille du régiemnt*), Philine (*Mignon*), Olympia, Rosina and Lakmé, for which she was most famous, particularly for the Bell Song.[57] She was truly an opera star and was featured in three Hollywood films: *I Dram too Much*, *Hitting a New Height*, and *That Girl from Paris*. She retired in 1962 after singing Lucia one last time.[58]

In a radio interview after her retirement, Pons discusses how she discovered and developed her voice. She describes herself as always singing as a child, saying, "I think I am born with my voice." When she did finally start to study, she worked first with a teacher in Cannes for 6 months, and then with Alberti di Gorostiaga, and after working with him, "In 6 months, the voice was completely different, it was just fantastic, and I was just needing his advice, [on the] placement of high note[s], they came naturally."[59] That she had to do so little study to find her voice, and to find the high notes, suggests an incredible natural instrument. That the high notes in particular "came naturally," that she only needed advice on their placement, really seems to show that she did not need to do much training to find them. Her recordings of her signature Bell Aria feature incredibly clear, bell-like and effortless sustained

[57] McIntire and Blyth, "Pons, Lily."
[58] von Tobien, "Pons, Lily."
[59] "Collectors Corner with Lily Pons."

*e'"*s as well as lightning-fast staccati. These notes seem light and easy like the whistle register, though there also does not seem to be a change in her sound from the head voice sound, so it is unclear to me if she is using damping or if her full folds are vibrating for these notes. In any case, her high notes are some of the greatest exemplars of what the human voice can do in this range.

Conclusions

Given the state of the scientific research, the mechanistic nature of these highest notes in the voice is still an open question: are the whistle register notes produced with damping, or are they produced with vibration along the full length of the folds? If the vibration is along the full length of the folds, how many different conformations of vibration are available? Furthermore, how do these different mechanisms align with different sounds? These questions remain unanswered for me, but the flurry of recent research demonstrates that this is an active field, in which we will hopefully see developments over the next few years.

In light of the research, the mechanism is used by modern operatic singers to reach these highest notes seems to be more often the vibration of the full length of the vocal folds, though of course more research is needed to know this more certainly. This is not the damping mechanism described by Emma Seiler, or Richard Miller for that matter, which I would guess that this damping mechanism was the one used by Calvé. It is unclear to me the mechanism of my own singing, but I would guess that it is not the same as Calvé's, or that perhaps it is sometimes but not always. Her sound in her recording of "Ma Lisette" seems much flutier, lighter, delicate, whereas mine is clear and piercing on *d'"*, *e'"*, and *f'"*. Though perhaps I have not yet passed the "miauling cat" stage, and if I spent more time training these notes, mine too could have this "strange, sexless, uncanny" sound.

In any case, the teaching methods for these higher notes remain the same. A hum, rolled r or voiced consonant of some sort allows easier access to the high notes. For some singers, such notes come naturally without training, others of us are not so lucky, and it can take time to gain stability and comfort in this area of the voice. Anat's method of going even higher, by placing the fingers on either side of the larynx in the gap between the hyoid bone and thyroid cartilage while training these notes is a helpful addition to this method.

The usefulness of such high notes becomes a question. I would not teach all my students to go to this register, only the ones who desired to do repertoire that goes higher than *a"* or students who had voices that already have an easy upper extension. Certainly, though,

any soprano singing operatic repertoire needs to develop a relationship to this register of the voice.

The fascination with these high notes was evident in the past, as was apparent in the case studies. Each of these singers were all singled out with astonishment and marvel for their incredible ranges, so much so that it was an integral part of their identity as singers. And as a singer who works on these notes, there is also something fascinating and powerful about learning these them, as it involves the discovery of the possibilities of one's own body. For me, learning to sing these high notes empowered me to believe I could make other changes in my voice and way of singing because these high notes were quantifiable progress, whereas so much to do with singing and timbre and sound is so qualitative and nebulous. From my own experience, I can only recommend studying and working on these notes, if only for the sense of empowerment that comes with more deeply discovering and understanding one's own voice, and therefore, inevitably, one's own self.

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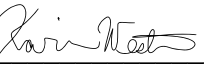
Unterschrift 

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